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THE VIRTUAL 3D REPRESENTATION OF OLD STREET CULTURE OF JINGTONG

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ABSTRACT

The purpose of this study is to preserve the old street culture of Jing tong, Taiwan. The illustration of this small town is made chronologically from Google historical photos of 2012 and 2015 to the current street scenes in 3D point cloud. The 3D scan data have been collected and carefully integrated for the most effective illustration of local cultures, such as railroads, lanterns, and wishing bamboo tubes. 3D scans were made by a Faro Focus 3D® laser scanner. Experiencing and comparing old street and railroad scenes through the 3D scan data has led to the discovery and illustration of a new fabric definition in terms of urban fixtures and the flexible part of the urban fabric.

KEYWORDS: Old Streets, Urban Fabric, Culture, Activity, 3D Scan & As-Built Data

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INTRODUCTION

Background

This research records urban fabric under a municipal scale based on the experience of touring route. This is part of a two-year study effort in scanning urban environments, which are closely related to people's daily living experiences. The scans were conducted in a small town in New Taipei City, Taiwan, including streets, railroad, and open spaces. In order to comprehend the local culture, the connection between urban scale and shop scale had to be established. The urban fabrics, as a collection of urban artifacts, usually configure consistent appearance and structure for years under a sparse framework that can achieve and interpret the cross-relationship and identity between buildings and street (Hull etc., 1994; Nüchter etc., 2011; Shih etc., 2011).

The representation of urban fabrics requires as-built data to verify the relationship between space and tourist's behavior. In order to present Realistic data from streets, the concepts of virtual cities (Chen etc., 2011) were promoted to include as-built city data to reflect the real content of an environment. Virtual 3D city models are becoming more widely implemented by governments and city planning services (Sadek etc., 2015; Stadler & Kolbe, 2013); this requires highly detailed 3D models that reflect the complexity of city objects and their interrelations.

The data from all platforms need to be exchangeable for the best description of an environment (Bishop & Escobar, 2000; Shih etc., 2013). Traditional 2D drawings are no longer sufficient. The technical- and policy-related barriers must be excluded from the institutional points of view (Rajabifard etc., 2012), so the data cross different ownership can be retrieved. Nowadays, city modeling has reached a new standard in which 3D point cloud models have been treated with rich geometric properties and rich details, which enable the clouds to be integrated with other city model types (Shojaei, 2012). Since the cloud models are as-built data, the integration with old environmental data leads to a specific application in showing the most current status of the environment or in contrasting the changes. The vast amount of data would open up opportunities in various fields of study (Shih etc.,

2013), especially when showing the complexity of city objects and their interrelations (Nebiker etc. 2010).

Now, Unmanned Aerial Vehicles (UAVs) or aerial LIDAR (Light Detection and Ranging) can add a more detailed description of as-built geometric information (Czyńska, 2015) with different levels of accuracy. However, the flying altitude and the level of details of the UAV can hardly meet the requirement of analysis. The Structure from Motion (SFM) based Photogrammetry modeling of ground scenes may sacrifice the geometry definition by merging adjacent objects. Although the visual definition is a great advantage for clearer presentation, to apply Photogrammetry at ground level still requires tremendous control of image orientations, foreground clearance, and registration tolerances in order to complete a large area model with a small town scale and narrow streets.

RESEARCH PURPOSE

This study explores the cultural and the urban fabric of Jingtong old streets with the major works as:

- Scan and illustration of the old street fabrics (Figure 1);
- Investigation of the street commercial activity and culture aspects;
- Present the potential conflicts between the residential area and the commercial activities;
- Scan of the spaces and structures around railroad.

The purpose of this research is to record urban fabric of Jingtong, New Taipei City, under a municipal scale. From the viewpoint of architectural details, the study is conducted from an urban scale to a building level, including street facade, open space, railroad, to local cultural activities. The 3D scan data have been collected and carefully integrated for the most effective illustration of local cultures. Experiencing a route through the 3D scanned data of urban fabric leads to the creation of a new fabric definition in terms of combining building enclosures and flexible part of the signage or urban furniture. Both the scan and Photogrammetry data can be applied as the most updated digital reference for urban 3D studio. A new application paradigm of 3D scan data is proofed to be useful in illustrating urban activities which is close-related to open space. The physical objects and user activity have been created as a connection between the virtual world and real world.

Figure 1: Point Cloud of Jing Tong Scan-Based Map (Top) and Old Street Scenes in Pairs (Photos to the Left and Point Clouds to the Right)

METHODS

Traditional 2D drawings or 3D Digital Terrain Models (DTM) used to be applied to the fundamental reference of spatial structures. GIS technology is also very helpful in the cognition and interpretation of the urban fabric status (Xiang & Ye, 2008). Nevertheless the level of vector details can hardly be competing with images and 3D scans.

By focusing the as-built environment, a 3D scanner is used to capture spatial data that associated with local culture. People recognize a space with different emphasis, so the scan-based virtual data are applied to illustrate subjects which are closely related to how an environment is usually perceived by people. The advantage is to identify a space or a location at the first sight, and the data should be precise enough for measurements in a 1:1 scale.

The Method has Twofold

- Chronological reference of images: Google Earth has been very helpful to display the images of urban development stages in a chronological manner. This study starts from retrieving historical Google street scenes, to initially verify the urban changes and then to identify the variations from 3D point cloud model. The comparisons are shown in Appendix. With the assistance of Google images, scan models can be taken and used to illustrate the development of urban models in addition to the current spatial-temporal framework, with the location-based information more sufficient for research and tourism.
- 3D scan: This study extended the size and the complexity of 3D scan to an urban environment by using a Faro Focus 3D® laser scanner. With a range of 80-120m, a street about 500 meters long was retrieved. The result is a set of cloud models of about 50 million points. To view the model, other than by the scanner's host platform, the data were exported under different resolutions to Meshlab®, Cloud Compare®, and Geomagic Studio® for registration and visualization purpose.

THE PRESENTATION OF URBAN SCENES IN TERMS OF STREET SECTIONS

The point-cloud-based urban scene can be seen in Figure 2. The scene is a combination of hill, railroad, trains, shops, residences, and people. In order to relate as-built artifacts to landscape, a series sections is made along the main east-west axis. The section is cut from scan data by dividing it into 5 zones as from A to E (Figure 3). The results show a number of types of boundary and adjacency next to the railroad, from a highly enclosed corridor near the street entrance to an open space between residences and hill. Among which, temporary installations like canopies and panels are applied by local shops to define their shop front and to shape the major street scene of Jingtong.

Figure 2: The Point-Cloud-Based Railroad and Urban Scene

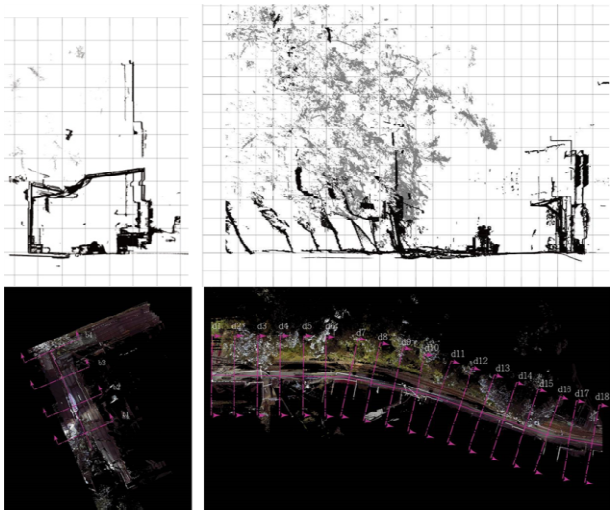

Figure 3: Two Point-Cloud-Based Sections of Major Space

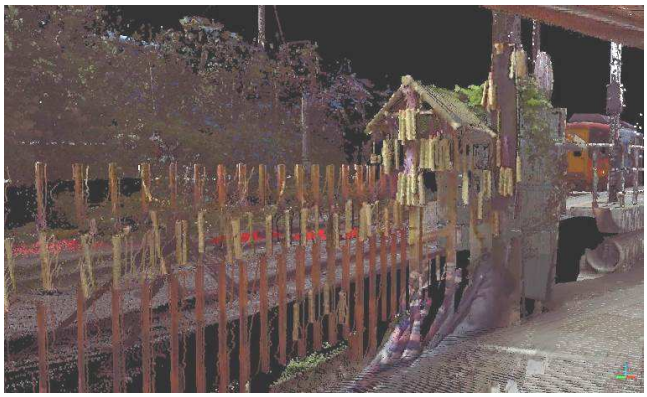

Figure 4: Locations for Hanging Wish-Making Bamboo Tubes

CULTURE ACTIVITIES ALONG THE RAILROAD AND OLD STREETS

The legend of bamboo tube came from an old love story of a local couple. This story has been circulated for a long time as a Jing tong-specific romantic memory (Department of Information and Tourism, 2015). In order to memorize and promote the legend, local community and commercial society hosted an activity in Valentine's Day, 2008, by providing free bamboo tube as a gift. Since then, the tubes have appeared in various locations and created a special urban scene.

The tube cluster generated a specific signature of local urban fabric (Figure 4), which is also changing. Comparing to 2012 Google Street Scene, no advertisement panels were installed in shops near railroad. Only a very small number of bamboo tubes were hung on the fence next to the railroad in the early days. The number increases significantly between 2012 and 2015 (Figure 5). To be noticed, the location of tube sock was relocated after the railroad platform remodeling (Figure 5).

Figure 5: Old (2012) and New (2015) Tube Scene near Railroad (Top Left & Right) of Google Earth and Current Scene (Bottom)

Figure 6: Lantern Booths and Their Point Cloud Representation

Walking environment in a commercial area is very important for pedestrians, as the related issues include basic functions, maintenance, quality, visual aesthetics, a number of activities, etc. The invisible linear space can be created without clearly defined boundary. In Jingtong, the street width is related to the connection of activities. The railroad, the sense of enclosure, and the shops like local Lantern booths (Figure 6) have created a specific local street scene.

CONCLUSIONS

To support a study from an urban scale to a detail level, the data have to be collected and carefully integrated for the most effective illustration of the subject. Experiencing old streets and railroad through the 3D scanned data of urban fabric has led to the creation of a new fabric definition in terms of building enclosures and cultural part of the fabric. The scan data can be used as the most updated digital reference for urban fabric study. Most important of all, a new application paradigm of 3D scan data is proofed to be useful in illustrating urban cultural activities which are closely related to tourist's experience, not just the 2D drawings or GIS data. The connection between the virtual world and real world has never been closer.

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APPENDICES

Appendis: Chronological monitoring of urban changes: the top two images come from Google Earth, the bottom image comes from point cloud screenshot, and the yellow lines indicate the changed part.

A: Gateway to the Old Street (Left) and the First Part of the Old Street (Right)

B: The Second Part of the Old Street (Left) and the Railroad Next to the Old Street (Right)

C: The Tree-Hanging Bamboo Tubes Cross the Railroad (Left) and the Pavement Next to the Rain Station (Right)

Figure 7